(1) ELM heat load simulations on W rods and (2) ITER Module 18

SNL Contributors:

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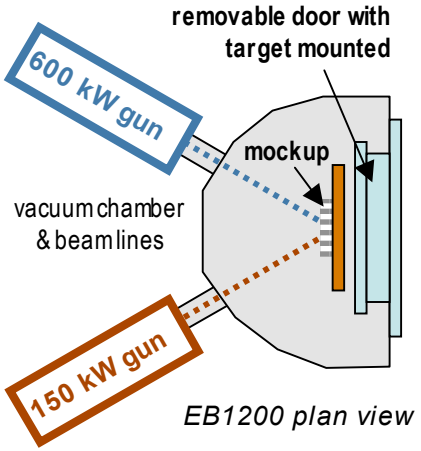
presented by: Richard Nygren

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.

1) ELM heat load simulations on W rods - update

EB1200

- 600kW beam fixes temperature of mockup.
- 150kW beam spot hits single rod for 2-5ms.



EB1200 plan view

The ITER Team is interested in Sandia's testing of W rod armor with many (10K) ELM-like heat pulses. The tests will:

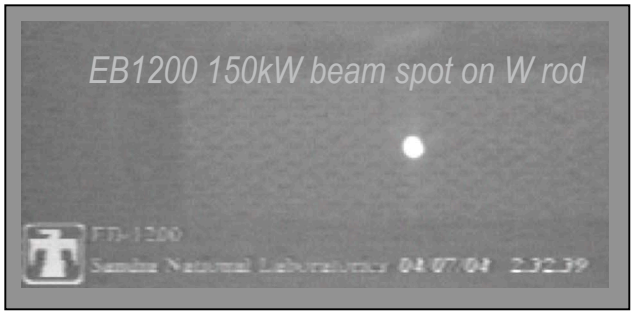
1) identify mechanisms for potential surface damage,
2) to complement ongoing Russian plasma gun tests.

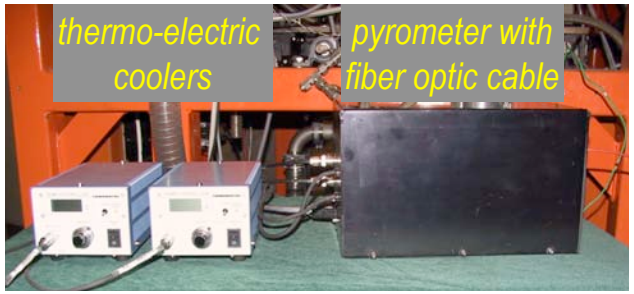
- Testing itself has been delayed due to limitations in personnel, repair of equipment and priorities for other tasks (EBTS and ITER).
- Oscillations in heat load (ripple in power supply) caused surface temperature fluctuations for 2-5 millisecond " ELM" pulses. This is unimportant for most tests but problematic in ELM heat load tests.
- We plan to resume testing in January.

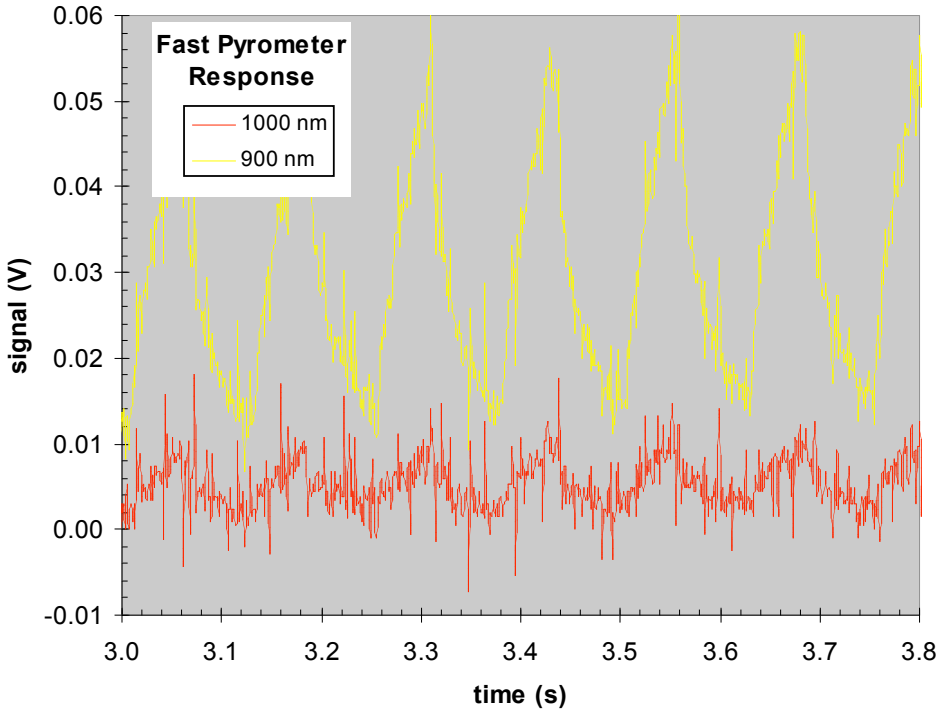
1) ELM heat load simulations - continued

Two important technology modifications

- **Dennis Youchison modified the e-beam control to give more precise ~2ms dwell (time on target).**
- **Dennis also developed the "fix" to reduce noise on the fast pyrometer.**







Don Long developed a fast (1MHz) 2-color pyrometer for disruption detection at PPPL.

We increased the time constant in the preamps to reduce noise and changed to thermoelectrically-cooled photodiodes, Hamamatsu model S2592

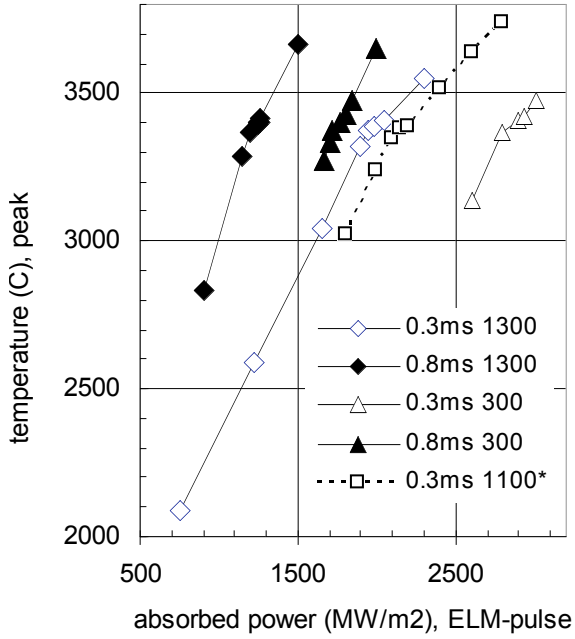
Curves show fast pyrometer channels at 900 and 1000nm tracking ~100ms heat pulses.

Novel high heat flux experiments using electron beam technology, DL Youchison et al., "E-Beam" Conference, Reno, Oct 2005

1) ELM heat load simulations - continued

Effort on thermal modeling continues for both ELM heat loads and steady state thermal response.

Thermal Modeling of W Rod Armor, RE Nygren, SOFT 2004



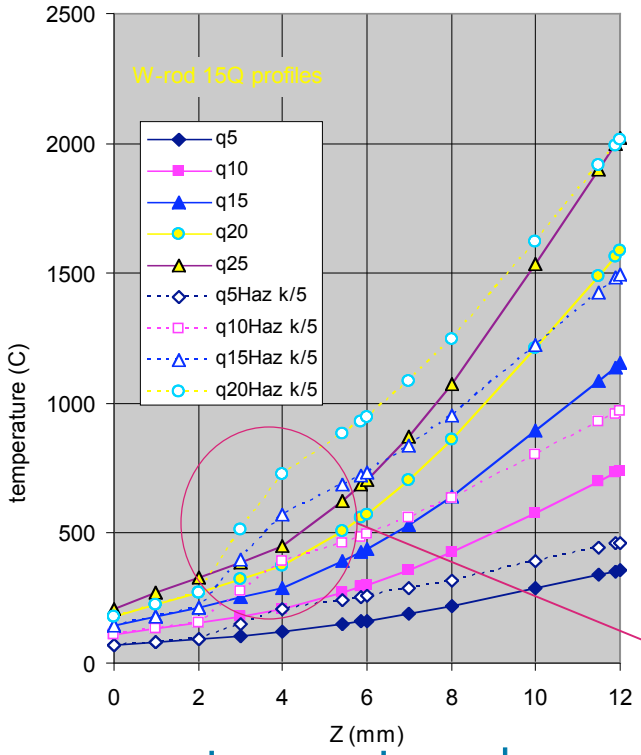
ELM heat load 2-D model

PPI mockup V2-02-15Q

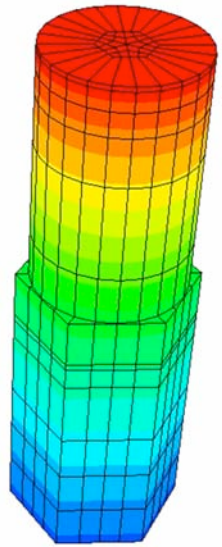
T_{peak} vs. q"$_{abs}$

T_{start}=302,1298°C; 300, 800μs

"0.3ms 1100*" is for 10mm rods



temperature along centerline

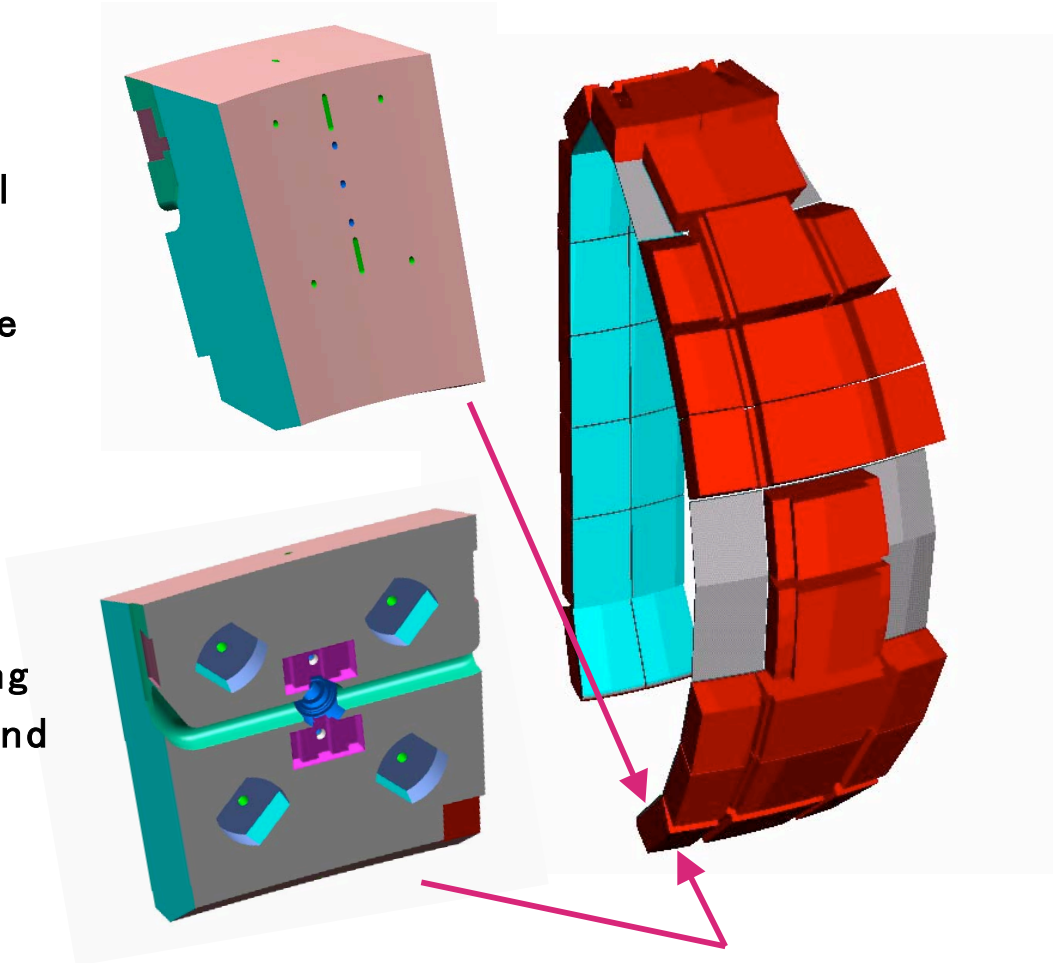


W-rod 3-D model

effect of poor ***k*** from metallurgical change (aging)

2) ITER Module 18

- FW/Shield (Blanket) module
  bottom of outboard first wall
  36 toroidal positions
- US commits to provide these units.



- Issues include:
  - complex mounting/cooling
  - heat loads, ELMs/VDEs and segmentation (EM loads)
  - ports/penetrations

2) ITER Module 18 - continued

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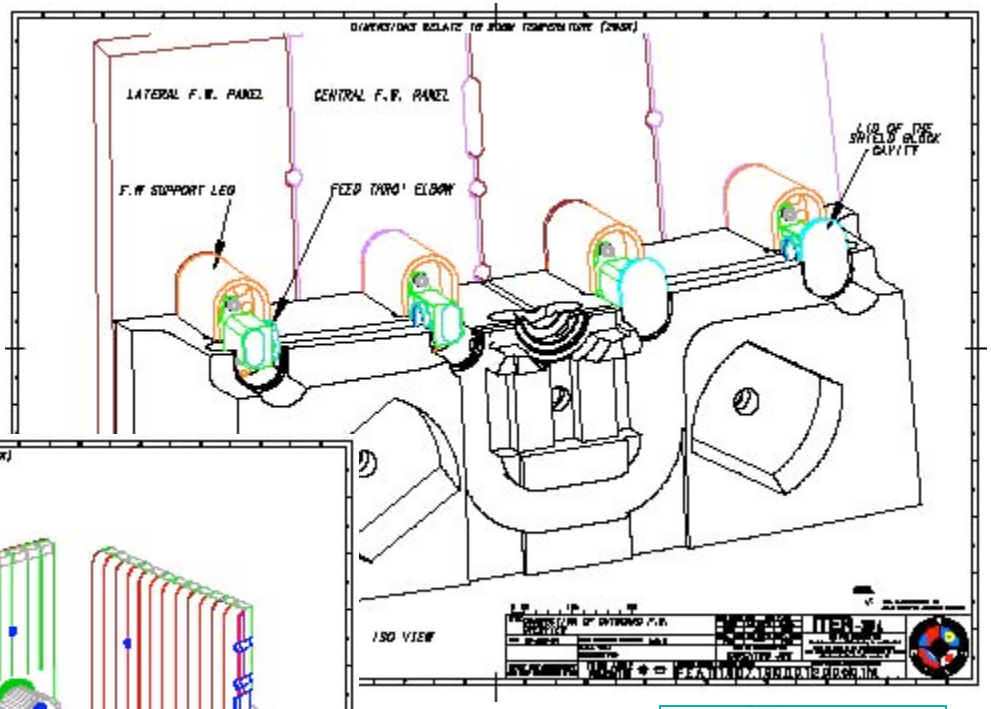
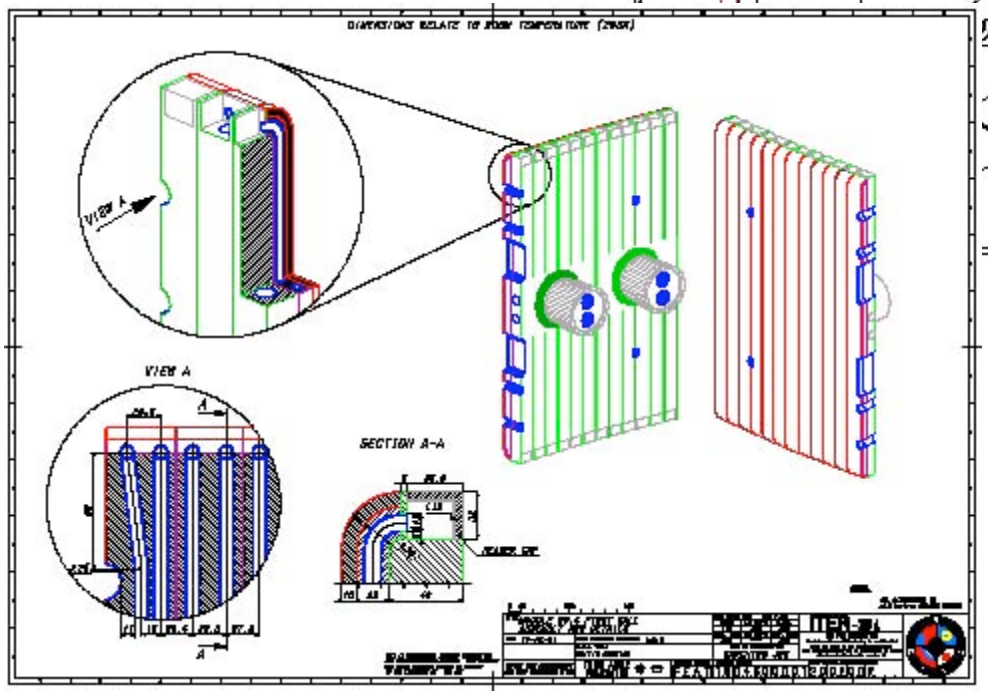
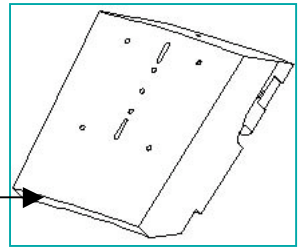




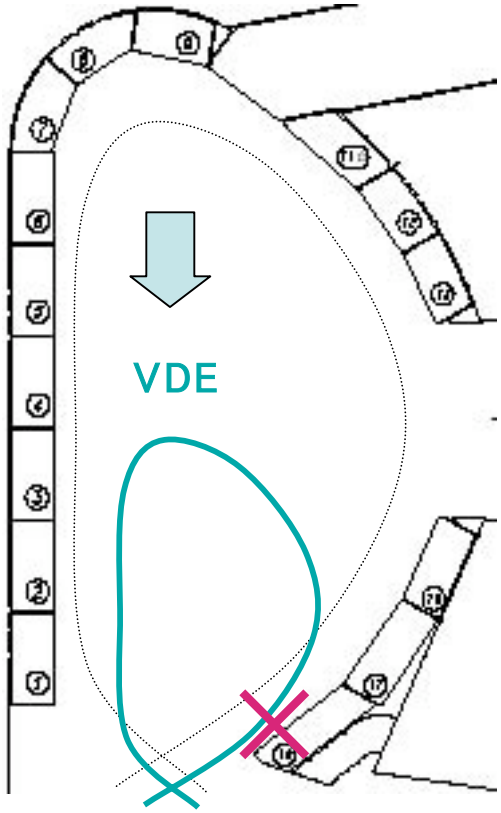


Lower edge of Mod18 FW rounds radially and adds complexity to design and fabrication of back FW.

2) ITER Module 18 - continued

- Issues include:
  - complex mounting/cooling
  - heat loads – ELMs/VDEs and segmentation (EM loads)
  - ports/penetrations

- Vertical Downward Disruptions *(VDEs) will tend to hit Mode18, baffle and divertor causing EM loads and heat loads.*
- Asymmetries in ELM heat loads *ELMs make Mod18 more vulnerable.*

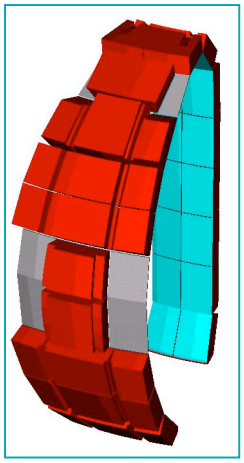


2) ITER Module 18 - continued

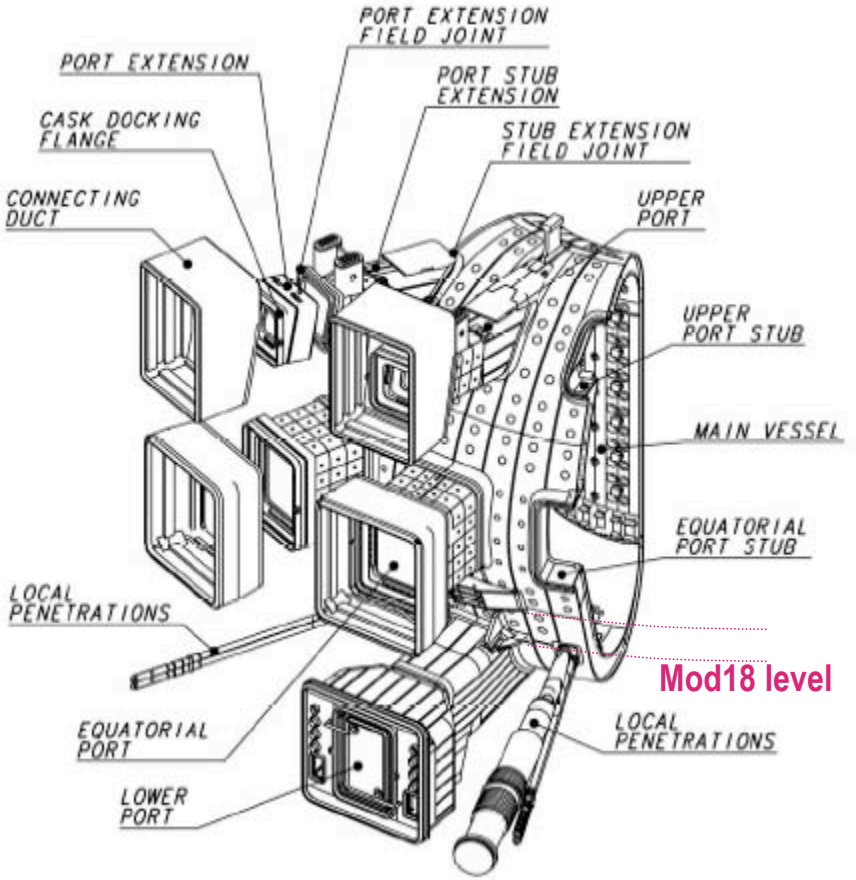
Issues include:

- complex mounting/cooling
- heat loads, ELMs/VDEs and segmentation (EM loads)
- ports/penetrations

  In-vessel viewing + GDC, vertical neutron camera, bolometer views, …



port	loca-tions	affected units
IVV/ GDC	6	12
VNC	1-2	1-2
Bolom.	4-6	4-6



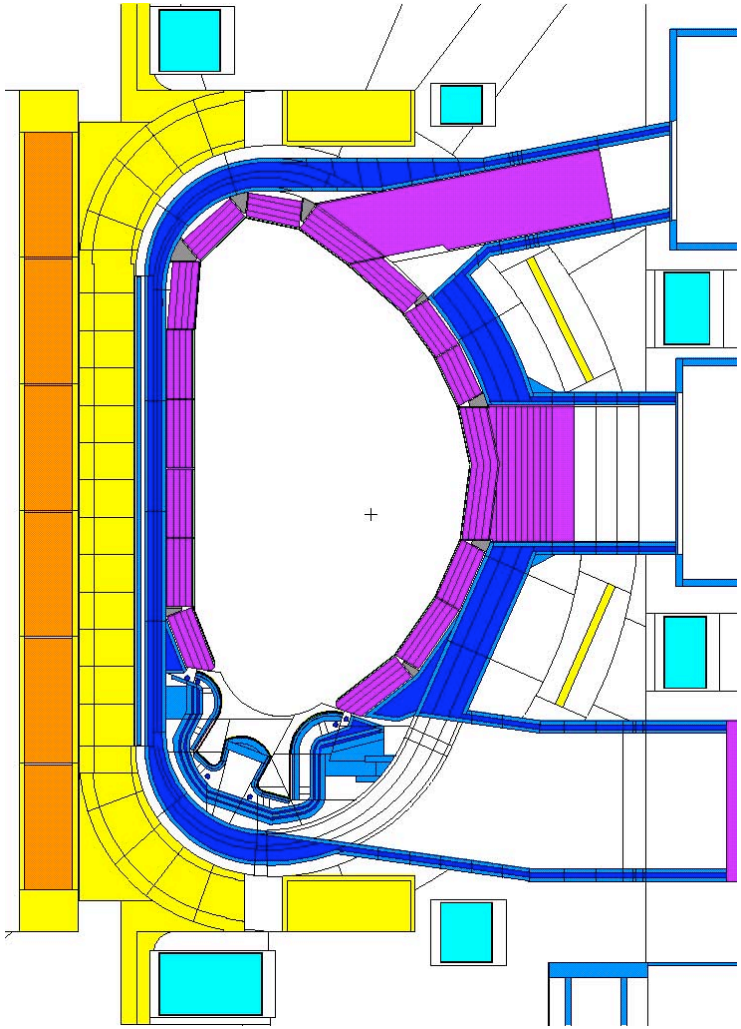
2) ITER Module 18 - continued

- Heat removal scheme

Design development and verification needed. Segmentation of Mod18 affects the design of the water (~25% of shield) and coolant passages.

OPTIONS?: Coolant path is complicated. There is an EFDA alternative. The US might prefer a "casting-based" approach.

US milestone of a Conceptual Design of Mod18 in FY2005 will likely preclude the investigation of any design alternative.



- Volumetric heating (neutronics)

Recent work (Nov. 2004) on triangular support by Iida et al.*

"Nuclear Heat deposition in the Blanket and Vacuum Vessel by Monte Carlo nuclear analyses with MCNP"

**ITER Naka Team*

G. Ruvutuso, H. Iida, L. Petrizzi, *NAG-171-15-11-00 15*, Nov. 2000

ITER Module 18 – other comments

- FW Partners - host, US, China, Korea, RF, ??
- ITER website - www.itereu.de
  access to design data, drawings … (with ITER account)
- Garching - Nygren at IPP ~7-10 days every 2 months
  link to good website for Garching from ITER
- Plan - conceptual design of Mod18 in FY2005
  (Mike Ulrickson presentation)

Our commitment to ITER is to deliver hardware that works.

We must: develop and confirm a workable design,
develop and qualify vendors,
develop fabrication and QA procedures,
identify and mobilize the talent we need in industry and our research institutions and get commitment to this project.